

## Sustainable Shadow Banking<sup>†</sup>

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*Banking regulation is beneficial because it constrains banks' portfolios to prevent excessive risk taking. But given that regulators usually know less than a bank about its investment opportunities, regulation comes at the cost of foregoing profitable investments. I argue that shadow banking improves welfare because it provides a channel to escape excessive regulation that is asymmetrically more valuable for banks with access to efficient investment opportunities. I propose a novel intervention that improves welfare further by taxing shadow activities, subsidizing regulated activities and allowing banks to self-select into being regulated or not. (JEL D82, G21, G28, G31, G32, L25)*

A well-known problem in financial markets is risk-shifting, wherein financial intermediaries tend to take excessive risks at the expense of depositors and other debtholders. At the heart of this problem lies an asymmetry in how intermediaries and debtholders acquire and process information to evaluate investments, combined with the inability of intermediaries to commit making the best available investments on behalf of debtholders.

In *traditional banking* risk-shifting is partially controlled by simple regulations that curb risk-taking. A commonly used regulation is *risk-weighted capital requirements*, which impose minimum levels of capital (“skin in the game”) that banks should hold as a fraction of their risk-weighted assets. Banks can relax these constraints either by raising more capital as a fraction of total assets or by holding a smaller fraction of assets that regulators broadly classify as risky (such as corporate debt, real estate or emerging markets sovereign debt).<sup>1</sup> These regulations, however, usually constitute a very crude solution. They rely on broad and imprecise definitions of assets that can force financial intermediaries to forgo attractive *superior* (high-return and low-risk) investment opportunities simply because (typically less informed and less knowledgeable) regulators roughly classify those opportunities as belonging to an excessively risky category.

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<sup>1</sup>Basel regulations, for example, classify assets into very broad classes to determine regulatory requirements. See [www.bis.org/bcbs/basel3.htm](http://www.bis.org/bcbs/basel3.htm) for the latest Basel III classification and risk weights.

In this paper, I highlight the fact that this regulatory solution may be useful to lessen the asymmetric information between banks and debtholders, but it is far from perfect because regulators do not have access to the same information about investments as banks. In short, capital requirements constitute both a blessing and a curse. They prevent investment in excessively risky assets but they also prevent investment in very efficient assets that are incorrectly classified as risky. Given that capital requirements are blunt, banks with access to superior investment opportunities that regulators fail to recognize as such have incentives to raise funds in the so-called *shadow banking*, which the Financial Stability Board (FSB) defines as “credit intermediation involving entities and activities outside the regular banking system.”

Shadow banking is a financial innovation that provides an efficient “escape route” to banks with access to superior investment opportunities, but it also provides the same route to banks with access to *inferior* (high-return and high-risk) investment opportunities. This reaction contaminates the use of shadow banking and increases its risk profile. I show that in equilibrium, however, the gains from higher investment efficiency overcome the losses from higher risks. While most of the literature starts from the premise that banks would rather not be regulated, in my model some banks value regulation because it provides an (imperfect) commitment device to avoid excessive risk taking. Given that shadow banking is most preferred (and used to avoid excessive regulation) by banks with access to better investment opportunities, I show that it improves allocations relative to a situation in which shadow banking is forbidden.

I also show that asset bubbles (in the model defined as a rise in the expected returns of risky assets) and higher leverage (in the model defined as a decline in bank capital) increase risk-shifting incentives and make shadow banking grow larger. These findings are consistent with the financial landscape evolution during the run-up to the 2007–2009 United States financial crisis, which was characterized by a large movement away from *traditional banking* into *shadow banking*. As Poznar et al. (2012) document, “at the eve of the financial crisis, the volume of credit intermediated by the shadow banking system was close to \$20 trillion, or nearly twice as large as the volume of credit intermediated by the traditional banking system at roughly \$11 trillion. Today, the comparable figures are \$16 and \$13 trillion, respectively.”

During this period, banks increasingly devised securitization methods to bypass capital requirements. An example was the sponsoring of asset-backed commercial paper (ABCP) *conduits*. These conduits are special purpose vehicles (SPV) designed to purchase and hold long-term assets from banks by issuing short-term ABCPs to outside investors. Since these assets are classified as off-balance sheet once they are held by SPVs, they are not considered for the purpose of computing capital requirements. Indeed, Gilliam (2005) computed that regulatory charges for conduit assets were 90 percent lower than regulatory charges for on-balance sheet assets. Furthermore, Acharya, Schnabl, and Suarez (2013) show that banks that were more heavily constrained by regulation used ABCP more intensively, which suggests that these conduits were indeed used to avoid regulatory pressures.<sup>2</sup>

<sup>2</sup>Interestingly, Acharya and Schnabl (2010) also note that Spain and Portugal are the only European countries that impose the same regulatory capital requirements for both assets on balance sheet and assets on ABCP conduits. Consistent with the regulatory arbitrage motive, banks in these countries do not sponsor ABCP conduits.

The growth of ABCP conduits exemplifies the growth of shadow banking. Acharya, Schnabl, and Suarez (2013) show that ABCP “grew from \$650 billion in January 2004 to \$1.3 trillion in July 2007. At that time, ABCP was the largest money market instrument in the United States. For comparison, the second largest instrument was Treasury Bills with about \$940 billion outstanding.” This increase came to a sudden halt on August 9, 2007, when BNP Paribas suspended withdrawals from three funds invested in mortgage-backed securities, revealing, if not to investors then to the rest of the economy, that shadow banking involved higher risks than more traditional banking.<sup>3</sup>

The collapse of shadow banking can be attributed to two forces. On the asset side, unregulated shadow activities allowed the origination of low-quality assets and the accumulation of excessive risks.<sup>4</sup> On the liability side, the main weakness was related to the fragility of wholesale funding and its exposure to panics and runs.<sup>5</sup> These two forces are intimately related. In this paper, I focus on the weakness that shadow banking introduces to banks’ assets. For a discussion of the second force see Ordoñez (2016).

As a response to the recent growth and collapse of shadow banking, comprehensive and broad reforms to the regulation of financial systems were initiated by the Basel Commission for Bank Supervision (via its Basel III accord) and the Dodd-Frank Wall Street Reform and Consumer Protection Act (DFA). One of the most relevant changes was the amendment of accounting rules for the consolidation of securitization transactions, particularly those that required depository institutions to hold regulatory capital against consolidated securities and ABCP conduits.<sup>6</sup> Furthermore, the Dodd-Frank Act (section 331) requires the assessments of consolidated assets minus tangible equity to compute liabilities instead of just considering deposit liabilities, as used to be the case before the reform. These changes were intended to increase the bureaucratic costs of sponsoring conduits and reduce the incentives to operate through shadow banking activities.<sup>7</sup>

In this paper, I show that choking off shadow banking activities is not an effective course of action because it does not only reduce risks in the financial system but also the possibility that banks will exploit superior information to invest more efficiently.<sup>8</sup> By enabling shadow banking activities the economy faces a higher risk of crisis, but from an *ex ante* perspective this is justified by a larger investment efficiency. In other words, shadow banking complements traditional banking to improve welfare.

<sup>3</sup>The recent growth and posterior collapse of shadow banking is not without precedent. During the late nineteenth century and early twentieth century there was no “regulation by a government,” but banks could choose to be members of clearinghouses that imposed “regulation by peers.” The growth of shadow banking at the time can be traced to the larger participation of trust companies, which were not operating under the rules of clearinghouses. From time to time investors became concerned about the credit quality and liquidation value of trust companies, and this induced collapses of “shadow banking.” See Frydman, Hilt, and Zhou (2015) for a discussion of these events during the bank run of 1907.

<sup>4</sup>For evidence of a deterioration in loan underwriting standards see Murfin (2012) and Dell’Ariccia, Igan, and Laeven (2012).

<sup>5</sup>See Gorton (2010) and Gorton and Metrick (2010a).

<sup>6</sup>See <https://www.gpo.gov/fdsys/pkg/FR-2009-09-15/pdf/E9-21497.pdf>.

<sup>7</sup>For a comprehensive analysis of all regulatory changes proposed in relation to shadow banking see Adrian and Ashcraft (2012).

<sup>8</sup>Others have also recognized the trade-off between more and better credit and more risk taking and fragility. See Adrian and Ashcraft (2012), Stein (2010), and, among legal scholars, Ricks (2010) and Schwarcz (2012).

In the absence of regulation, banks take too much risk. In the absence of shadow banking, efficient investments are lost. A combination allows for a superior mix of investment efficiency and risks.

Exploiting this complementarity, I show that there is an intervention that implements a direct revelation mechanism and achieves the best of both worlds—that is, no excessive risk-taking and full investment efficiency. Instead of suffocating shadow banking, which is the explicit purpose of many new regulatory proposals, regulators should instead allow banks to decide whether or not they want to be regulated. Banks that choose to avoid regulation would be taxed and the proceedings used to subsidize banks that choose to be regulated and operate under restrictive capital requirements. In other words, instead of forcing all banks to be regulated it is more efficient to let them choose, taxing those that prefer not to be overseen by regulators and subsidizing those that decide otherwise.

With the right set of taxes and subsidies, banks with access to superior assets would prefer to avoid regulations in order to invest in those superior assets, even after they pay the tax. In contrast, banks with access to inferior assets would rather self-selecting into regulated activities, invest in safe assets and be subsidized. My novel proposed intervention purposefully maintains fixed the level of capital requirements, as I intend to highlight the need for a comprehensive regulatory reform that exploits both cross-subsidization elements and standard supervisory regulations.

The idea that regulatory constraints trigger financial innovation is a long-standing tradition in the literature (see Silber 1983 and Miller 1986). Yet, despite recent heated debates about how to regulate the new financial landscape, the literature that formally links regulatory arbitrage and shadow banking is scarce. An exception is Plantin (2015), who argues that “relaxing capital requirements for traditional banks so as to shrink shadow activity may be more desirable than tightening them.” In his paper, governments can implement optimal regulations, and, therefore, shadow banking always reduces welfare.<sup>9</sup> In my paper, governments are constrained in their knowledge and in how much they can improve welfare through regulation. I emphasize a trade-off that regulators face between preventing efficient investments and discouraging excessive risk-taking, and I show that is not optimal to discourage shadow banking.

Hanson, Kashyap, and Stein (2011) also argue that recent proposals to heighten capital requirements for traditional banks can trigger even more regulatory arbitrage, thereby inducing a large migration of activities toward the unregulated shadow banking system. My paper proposes that in addition to capital requirements a novel cross-subsidization should be implemented. Taxing shadow banks and subsidizing traditional banks induces only banks with access to superior investment opportunities to efficiently escape regulation; banks that otherwise would take excessive risk self-select into being overseen by regulators. I argue that we should ask not how many banks migrate to shadow banking but which banks do.

My paper focuses on regulation that intends to steer risk-taking and is silent about liquidity issues. For the literature on the latter topic see Gorton and Metrick (2010b),

<sup>9</sup>See also Harris, Opp, and Opp (2014) for a discussion of commercial banks that rather than engaging in shadow banking activities themselves, compete with shadow banking institutions.

who structure their proposal to regulate shadow banking around the idea that the key of securitization is its bankruptcy remoteness, and Ricks (2010) who proposes that the safety net of public insurance should be extended to shadow banking in order to reduce the latter's fragility.

My work explores not the intricacies of securitization but how securitization can improve welfare by avoiding regulation. For a rationalization of why banks use securitization to avoid regulation instead of other instruments see Gennaioli, Shleifer, and Vishny (2013), who focus on the risk-sharing properties of securitization; Adrian and Shin (2009) and Shin (2009), who argue that securitization facilitates reaching investors and having access to more funds; and Ordoñez (2016), who concludes that reputation concerns may be a more efficient market disciplining device than the imperfect discipline imposed by regulators.

In the next section, I introduce a model in which banks choose whether to raise funds through traditional or shadow banking activities. I show that regulation is better than laissez-faire and that shadow banking improves welfare above and beyond regulation, but it does not implement the first-best allocation. In Section II, I solve for a direct revelation mechanism and discuss an implementation with taxes and subsidies that achieves the unconstrained first best by exploiting the complementarity between traditional and shadow banking. In Section III, I make some concluding remarks.

## I. Model

I consider a single-period economy that consists of a (mass 1) continuum of banks and investors plus a government. Investors are endowed with a unit of numeraire good at the beginning of the period and only value consumption, with risk-neutral preferences, at the end of the period. Investors have access to a (no return) safe storage technology within the period; thus, they can choose to consume their endowment with certainty at the end of the period.

Banks are endowed with  $\kappa$  units of numeraire, also at the beginning of the period, and have access to more productive but riskier investment opportunities than investors. A bank can invest in assets that come in two forms, both of which are available at the beginning of the period: “safe assets” ( $s$ ) that pay  $y_s$  per unit of investment with probability  $p_s$  at the end of the period, and 0 otherwise; and “risky assets” that pay  $y_r > y_s$  per unit of investment in the case of success. Risky assets can be of two types: a fraction  $\alpha$  of banks have access to a *superior* risky asset ( $r_s$ ) that succeeds with probability  $p_s$  (the same as safe assets), and a fraction  $1 - \alpha$  has access to an *inferior* risky asset ( $r_i$ ) that succeeds with a lower probability  $p_r < p_s$ .<sup>10</sup>

If a bank borrows a unit of numeraire to invest and promises to repay  $R$  in case the asset succeeds, I make the following assumptions about the assets' payoffs.

<sup>10</sup>To fix ideas with an example, a “safe asset” can be a prime mortgage while a “risky asset” can be a subprime mortgage. Among the latter, however, a bank can recognize a “superior” subprime mortgage: a “strong” borrower, for instance, who can convincingly show that his low credit rating was the result of a past idiosyncratic health shock that does not affect his future income and repayment possibilities.



## ASSUMPTION 1 (Assets' Payoffs):

- (i)  $p_s y_r > p_s y_s > p_r y_r > 1$  (*superior risky assets pay more in expectation than safe assets, which pay in expectation more than inferior risky assets. All assets are ex ante efficient*).
- (ii)  $p_s y_s > \alpha p_s y_r + (1 - \alpha) p_r y_r$  (*safe assets pay more in expectation than risky assets*).
- (iii)  $(1 + \kappa) y_r > (1 + \kappa) y_s > R$  (*successful assets are enough to repay  $R$* ).
- (iv)  $p_s [(1 + \kappa) y_r - R] > p_r [(1 + \kappa) y_r - R] > p_s [(1 + \kappa) y_s - R]$ . (*risk-shifting: including funding costs, it is more profitable for banks to invest always in risky assets*).<sup>11</sup>

In short, these assumptions imply that from a social standpoint all investments are ex ante efficient. Absent information about risky asset types, it is socially efficient to invest in safe assets. With information about risky asset types, it is socially efficient to invest in risky assets when risky assets are superior and in safe assets when risky assets are inferior. However, when a bank accounts for the cost of funding, both superior and inferior risky assets pay more in expectation than safe assets.

In terms of the information structure, I assume that (i) banks have the skills to distinguish between safe and risky assets, and in the case of the latter between superior and inferior risky assets; (ii) the government lacks these skills but has access to a monitoring technology that distinguishes between safe and risky assets, but not between superior and inferior risky assets; and (iii) investors do not have the skills nor the monitoring technology to distinguish between safe and risky assets. In summary, assume the following.

ASSUMPTION 2 (Information Structure): *Banks can distinguish all asset types, the government can just distinguish between safe and risky assets (not between superior and inferior risky assets), and investors cannot distinguish any asset type.*

These informational differences can arise from differences in the ability of banks to process information or from differential access to information—for example, the details of investments prospects. Consider mortgage-backed securities, for example. Banks usually have access to very specific details about a mortgage pool (such as the address of each mortgage in the pool, financial statements, and credit ratings of each borrower in the pool, etc.); regulators (or the government more generally) usually check basic information (such as the pool's investment grade, aggregate

<sup>11</sup> The rate  $R$  is endogenous and I show later that  $R \in [\frac{1}{p_s}, \frac{1}{p_r}]$  in equilibrium. Hence, although the assumption can be written purely in terms of primitives, I refrain from doing so in order to avoid confusion and to highlight the role of funding costs  $R$  to create risk-shifting incentives.

characteristics of the pool, etc.); and investors have very scarce information about the composition of the bank's portfolio and the particular mortgage pool it holds.<sup>12</sup>

The asymmetric access to information is only relevant if banks cannot commit to using their superior information on behalf of investors, which I assume, henceforth. I also assume, however, that the government can use regulation to enforce investments, which indeed provides a commitment technology to banks—a bank can credibly convey to investors investments in safe assets by showing it is overseen by regulators. Yet the government is not as knowledgeable as banks about investing, and so regulation provides an *imperfect commitment* technology to banks.

As investment in any asset is better than storage, a bank always wants to borrow as much as possible from investors to finance the most profitable available asset. I assume that investors compete, which I capture by imposing a random match between a single bank and a single investor, with the bank offering the investor a take-it or leave-it offer for its unit of endowment. Banks borrow by issuing debt, either through *traditional banking* (*TB*) or *shadow banking* (*SB*).<sup>13</sup> The use of traditional banking implies issuing debt that is subject to a regulation that restricts investments to safe assets. The use of shadow banking implies issuing debt-like securities that are purposefully designed to avoid regulation that restrains investments.<sup>14</sup>

Before characterizing the equilibrium in this economy, I first describe the timing of events. Then I define the equilibrium objects and the equilibrium concept, and finally I describe as benchmarks the *laissez-faire* and unconstrained first-best allocations in this economy.

**Timing:** At the beginning of the period each bank observes whether it has access to a superior or an inferior risky asset. Based on this information the bank decides whether to raise funds by issuing debt through traditional or shadow banking, which offer interest rates  $R_{TB}$  or  $R_{SB}$ , respectively, to its matched investor, who then decides whether or not to lend. After obtaining the funds, the bank makes investment decisions. If the bank issues debt in traditional banking, it is forced by regulation to invest in the safe asset. If the bank issues securities, it chooses whether to invest in the risky or in the safe asset (because it operates in the “shadows” of the regulator), but investors cannot observe this choice. At the end of the period, the asset payoffs are realized and contracts are enforced.

**Equilibrium:** Banks follow three sequential strategies. First, a *financing strategy*: conditional on whether the bank's risky asset is superior or inferior, a bank chooses the probability  $\sigma_F$  of using shadow banking to raise funds, this is

<sup>12</sup>The fact that investors do not have specific information about the bank's assets can be attributed either to technological constraints or to the optimal provision of money-like liabilities, as in Dang et al. (2017).

<sup>13</sup>In our setting assets either succeed or fail: in the latter case they do not generate any cash-flow, and so the difference between debt and equity is immaterial. In a more general setting, debt is optimal in the presence of costly state verification, as in Townsend (1979) and Gale and Hellwig (1985), or it provides liquidity because of its information-insensitiveness, as in Gorton and Pennacchi (1990) and Dang, Gorton, and Holmström (2015). I just assume these micro foundations and just impose banks issue debt because I am interested in studying its risk-shifting considerations.

<sup>14</sup>When analyzing the choice between these two funding possibilities, I justify these differences by describing in detail their institutional characteristics and how regulators can effectively restrict investments through the use of capital requirements.

$\sigma_F : \{s, \{r_s, r_i\}\} \rightarrow [0, 1]$ . Second, a *pricing strategy*: conditional on the regulatory environment chosen, the bank makes a take-it or leave-it offer to the randomly assigned investor for funds. This is  $\sigma_R : \{s, \{r_s, r_i\}\} \times \{TB, SB\} \rightarrow R \in \mathbb{R}$ . Third, an *investment strategy*: conditional on the bank's assets, regulatory environment, and financing costs, the bank chooses the probability  $\sigma_I$  to invest in the safe asset, this is  $\sigma_I : \{s, \{r_s, r_i\}\} \times \{TB, SB\} \times R \rightarrow [0, 1]$ . Investors choose whether or not to lend to the randomly assigned bank, conditional on the regulatory environment, the rate proposed by the bank, and the investor's beliefs about the bank's strategies ( $\hat{\sigma}_F(r)$  and  $\hat{\sigma}_I(r)$  for all banks  $r \in \{r_s, r_i\}$ ), this is  $\tau : \{TB, SB\} \times R \times \{\hat{\sigma}_F(r), \hat{\sigma}_I(r)\} \rightarrow \{\text{lend, do not lend}\}$ .

In what follows I characterize the subgame perfect equilibrium of the game, proceeding by backwards induction. I first solve the banks' investment and pricing strategies and investors' strategies in equilibrium, for traditional and shadow banking separately, such that investors' beliefs about banks' strategies are correct (this is  $\hat{\sigma}_F(r) = \sigma_F(r)$  and  $\hat{\sigma}_I(r) = \sigma_I(r)$  for all banks  $r \in \{r_s, r_i\}$ ). Then I obtain the banks' profits in each case and characterize the banks' financing strategy in equilibrium.

**Benchmarks:** As asset payoffs are linear, all assets are ex ante efficient, and agents are risk-neutral, the *unconstrained first-best* features the investment of all the endowment ( $\kappa$  from banks and 1 from investors) in the assets with the highest NPV: superior risky assets for the fraction  $\alpha$  of banks with access to them and safe assets for the rest of banks. This allocation implies an unconstrained first-best utilitarian welfare of

$$(1) \quad U^* = (1 + \kappa)p_s(\alpha y_r + (1 - \alpha)y_s).$$

AQ1 In the *laissez-faire* benchmark, in the absence of regulation, banks are not differentiated by their participation in different banking systems and they pay the same rate for funds  $R$ . According to Assumption 1, point (iv), all banks would rather invest in the risky asset, and welfare would be

$$(2) \quad U_{LF} = (1 + \kappa)(\alpha p_s + (1 - \alpha)p_r)y_r < U^*.$$

### A. Traditional Banking

Traditional banking implies issuing debt directly to investors, such as collecting demand deposits in the case of commercial banks. Debt faces well-understood risk-shifting incentives, and so banks are usually subject to regulations designed to directly restrict the riskiness of investments at origination. A commonly used form of such regulation is risk-weighted capital requirements. As I will derive later, an *optimal regulation* that involves cross-subsidizations. I will refer in what follows to capital requirements simply as *standard regulation*.

How can risk-weighted capital requirements restrict investments? Regulators can always steer a banks' portfolio composition and risk exposure by assigning "risk



weights” to different asset classes (say  $\omega_s$  for safe assets and  $\omega_r$  for risky assets in the model) and minimum capital requirements (denote it by  $\chi$ ) such that the ratio of capital ( $\kappa$  in the model) to risk-weighted assets is only higher than the minimum capital requirement if the bank invests in safe assets. This is,

$$\frac{\kappa}{\omega_s E(v_s)} > \chi > \frac{\kappa}{\omega_r E(v_r)},$$

where  $E(v_s) = (1 + \kappa)p_s y_s$  is the expected (market) value of safe assets and  $E(v_r) = (1 + \kappa)(\alpha p_s + (1 - \alpha)p_r)y_r$  is the expected (market) value of risky assets (as the regulator cannot identify whether the risky asset is superior or inferior).<sup>15</sup>

Based on this logic and the fact that I consider just two broad assets classes in the model, I simply assume that regulators choose the regulatory parameters  $\omega_s$ ,  $\omega_r$ , and  $\chi$  (given  $\kappa$ ,  $E(v_s)$ , and  $E(v_r)$ ) to implement risk-weighted capital requirements such that a bank can operate according to regulation only if it invests in safe assets.<sup>16</sup>

Having set this standard regulation such that  $\sigma_I^*(TB) = 1$  for both  $\{r_s, r_i\}$  and all  $R_{TB}$ , the expected probability of repayment in traditional banking is  $p_s$ , which is the probability that a safe asset succeeds, independent of the volume and composition of banks that participate in traditional banking. As banks have all the bargaining power when offering rates and the investors’ outside option is a risk-free storage technology with no return, the interest rate  $R_{TB}$  equalizes the loan with expected repayment,

$$(3) \quad R_{TB}^* = \frac{1}{p_s}.$$

As banks are forced to invest in safe assets, banks’ profits in traditional banking are independent of the risky asset type and of investors’ beliefs about participation in shadow banking. This is

$$(4) \quad \begin{aligned} \Pi_{TB} &= \kappa(p_s y_s - 1) + p_s(y_s - R_{TB}^*) \\ &= (1 + \kappa)(p_s y_s - 1). \end{aligned}$$

<sup>15</sup>Regulators usually define these weights by considering the failure probability of each asset (for instance,  $\omega_s = 1 - p_s$ ). Risky assets are relatively less likely to repay in expectation than safe assets (by Assumption 1), and so  $\omega_s < \omega_r$ . This is consistent with Basel standardized risk weights assigned to broad asset classes. For example Basel III assigns a weight of 0 percent to cash or US T-Bills, 50 percent to first lien residential mortgages, and 100 percent to corporate bonds and other residential mortgages.

<sup>16</sup>Banks could also relax the constraint and still invest in risky assets by raising more equity (increasing the numerator). As discussed in Dang et al. (2017), however, this possibility is usually limited because it increases the incentives for investors to acquire information about banks, which constrains banks’ provision of money-like assets. Although I abstract from this discussion in order to focus on banks’ financing decisions, modeling both choices in a single setting would be an interesting extension for further research.

### B. Shadow Banking

The use of shadow banking implies issuing debt-like securities, which I simply refer to as *securitization*, with all the potential advantages of debt (such as providing “private money”) that are not subject to regulatory constraints. A form of securitization commonly used in recent years was the sponsoring of ABCP conduits. In the model this is captured when the bank sponsors a special purpose vehicle (SPV), which operates as a master trust and purchases a fraction of the asset from the bank that uses funds raised by issuing short-term ABCP to investors. These are debt-like securities backed (collateralized) by the fraction of the asset that the SPV acquires from the bank. If investors charge  $R_{SB}$  to lend their unit of numeraire to an SPV, the bank has to sell  $R_{SB}$  of the asset to the SPV.

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In the model, by selling part of the asset and placing it off-balance sheet, banks can avoid investment restrictions if capital requirements do not bind when investing in risky assets. This is, banks avoid regulations as long as

$$\frac{\kappa}{\omega_s [E(v_s) - R_{SB}]} > \frac{\kappa}{\omega_r [E(v_r) - R_{SB}]} > \chi.$$

Henceforth, I assume that this condition is fulfilled; thus, banks’ investments are not restricted to safe assets when they use securitization. According to Assumption 1, point (iv)), banks invest exclusively in risky assets if they are not regulated,  $\sigma_I(SB) = 0$ , for  $r \in \{r_s, r_i\}$  and all  $R_{SB}$ .

Now, I derive the equilibrium interest rate in shadow banking. Define the fraction of banks with access to superior risky assets that participate in shadow banking as

$$x_s \equiv \frac{\alpha \sigma_F(r_s)}{\alpha \sigma_F(r_s) + (1 - \alpha) \sigma_F(r_i)},$$

for a given participation of banks with access to superior and inferior risky assets in shadow banking,  $\sigma_F(r_s)$  and  $\sigma_F(r_i)$ , respectively. Banks with access to superior risky assets that issue securities invest in those assets, which succeed with probability  $p_s$ . Similarly, banks with access to inferior risky assets that issue securities also invest in those risky assets, which succeed only with probability  $p_r$ . As banks have all the bargaining power, the interest rate  $R_{SB}$  equalizes the unit of loan with expected repayment,

$$(5) \quad R_{SB}^* = \frac{1}{x_s p_s + (1 - x_s) p_r}.$$

Notice that if only banks with access to superior risky assets participate in shadow banking,  $x_s = 1$  and then  $R_{SB|_{x_s=1}}^* = R_{TB}^*$ . In contrast, if only banks with access to inferior risky assets participate in shadow banking,  $x_s = 0$  and  $R_{SB|_{x_s=0}}^* = \frac{1}{p_r} > R_{TB}^*$ . This is why  $R_{SB} \in \left[ \frac{1}{p_s}, \frac{1}{p_r} \right]$  and Assumptions 1, point (iii) and point (iv) should hold for all  $R$  in this range.

Expected profits for banks that finance through shadow banking depend both on their risky asset's type (as they invest in those assets) and on the interest rate that investors charge in shadow banking, which depends on beliefs about which banks participate in shadow banking. This is,

$$(6) \quad \Pi_{SB}(r_s) = \kappa(p_s y_r - 1) + p_s(y_r - R_{SB}^*) = p_s[(1 + \kappa)y_r - R_{SB}] - \kappa;$$

$$(7) \quad \Pi_{SB}(r_i) = p_r[(1 + \kappa)y_r - R_{SB}^*] - \kappa,$$

for banks with superior and inferior risky assets, respectively.

Notice that both banks pay the same rate but face different probability of success. Thus, the expected profits of banks with access to superior risky assets that securitize are always larger than those with access to inferior risky assets that securitize.

### C. Coexistence of Traditional and Shadow Banking

Here I characterize the equilibrium set. In the previous two sections I obtained the financing costs involved in traditional and shadow banking as a function of beliefs about which banks participate in each activity. Now I study the participation of banks with access to superior and inferior risky assets in each activity that is consistent with those beliefs.

There is always an equilibrium with shadow banking, in which all banks with access to superior risky assets raise funds in shadow banking (so they are not restricted from investing in their superior assets), and banks with access to inferior risky assets strictly randomize between participating in traditional and in shadow banking. This implies that there is *no* equilibrium with full separation and there is *no* equilibrium with full pooling in shadow banking (that is, there is no equilibrium without traditional banking). I also show that an equilibrium with full pooling in traditional banking (that is, an equilibrium without shadow banking) is only sustained by particular off-equilibrium beliefs.

Before characterizing the equilibrium formally in the next proposition, I define

$$\Delta^+ \equiv (1 + \kappa)[p_s y_r - p_s y_s]$$

as the additional expected payoffs of investing in superior risky assets relative to investing in safe assets and

$$\Delta^- \equiv (1 + \kappa)[p_s y_s - p_r y_r]$$

as the additional expected payoffs of investing in safe assets relative to investing in inferior risky assets.

**PROPOSITION 1:** *The equilibrium is characterized by: (i) all banks with access to superior risky assets finance in shadow banking ( $\sigma_F^*(r_s) = 1$ ) and invest in those superior risky assets; and (ii) a fraction  $\sigma_F^*(r_i) \in (0, 1)$  of banks with access to inferior risky assets finances in shadow banking and invests in those assets, while*

the rest finance in traditional banking and invest in safe assets. Traditional banking rates are  $R_{TB}^* = 1/p_s$  and shadow banking rates are such that

$$(8) \quad \Delta^- = 1 - p_r R_{SB}^*(\sigma_F^*(r_i)).$$

The sufficient condition for this equilibrium to be unique is  $\Delta^+ \geq \frac{p_s - p_r}{p_r}$ . Otherwise, there are off-equilibrium beliefs that sustain another equilibrium without shadow banking.

PROOF 1:

Consider first an equilibrium with shadow banking.

First, there is no equilibrium in which  $\sigma_F(r_s) > 0$  and  $\sigma_F(r_i) = 0$ . In this proposed equilibrium  $x_s = 1$  and  $R_{TB} = R_{SB} = 1/p_s$ . Banks  $r_s$  do not deviate from the proposed strategy (indeed  $\sigma_F(r_s) = 1$ ) because

$$\Pi_{SB}(r_s) = p_s \left[ (1 + \kappa) y_r - \frac{1}{p_s} \right] - \kappa > \Pi_{TB} = p_s \left[ (1 + \kappa) y_s - \frac{1}{p_s} \right] - \kappa,$$

as  $\Delta^+ > 0$ . Banks with access to inferior risky assets, however, always deviate from the proposed strategy because

$$\Pi_{SB}(r_i) = p_r \left[ (1 + \kappa) y_r - \frac{1}{p_s} \right] - \kappa > \Pi_{TB} = p_s \left[ (1 + \kappa) y_s - \frac{1}{p_s} \right] - \kappa,$$

according to the risk-sifting Assumption 1, point (iv). This implies that full separation is not an equilibrium because banks with access to inferior risky assets would rather raise funds in the shadow banking at the same rates that apply in traditional banking and avoid regulation.

Then, an equilibrium with shadow banking should involve the participation of  $r_i$ -banks. As  $\sigma_F(r_i) > 0$ , by comparing equations (6) and (7),  $\sigma_F^*(r_s) = 1$ . The optimal strategy  $\sigma_F^*(r_i)$  is determined by the point at which  $r_i$ -banks weakly prefer to participate in shadow banking. This is

$$\Pi_{SB}(r_i | \sigma_F^*(r_i)) = p_r \left[ (1 + \kappa) y_r - R_{SB}^*(\sigma_F^*(r_i)) \right] - \kappa \geq \Pi_{TB}$$

or

$$R_{SB}^*(\sigma_F^*(r_i)) \leq \frac{1 - \Delta^-}{p_r}.$$

In equilibrium,  $\sigma_F^*(r_i) < 1$ . Otherwise  $R_{SB}^*(\sigma_F^*(r_i) = 1) = \frac{1}{\alpha p_s + (1 - \alpha) p_r}$  and by Assumption 1, point (ii),  $\Delta^- > 1 - p_r \frac{1}{\alpha p_s + (1 - \alpha) p_r}$ . This implies that an equilibrium with pooling in shadow banking (hence, without traditional banking) does not exist. In words, if all  $r_i$ -banks participate in shadow banking, the rate is so high that a single  $r_i$ -bank prefers to deviate and be regulated.

Then, an equilibrium with shadow banking is such that  $\sigma_F^*(r_i)$  solves equation (8). As

$$\frac{\partial R_{SB}(\sigma_F(r_i))}{\partial \sigma_F(r_i)} = \frac{(p_s - p_r)(1 - \alpha)x_s}{[\alpha + (1 - \alpha)\sigma_F(r_i)]} R_{SB}^2(\sigma_F(r_i)) > 0,$$

the equilibrium with shadow banking is unique.

Finally, an equilibrium with no shadow banking (with pooling in traditional banking) is one with  $\sigma_F(r_s) = \sigma_F(r_i) = 0$ . In this case,  $R_{SB}$  is not pinned down and depends on off-equilibrium beliefs when observing a bank that raises funds in the shadow banking. If off-equilibrium beliefs are the most “optimistic” (investors believe the deviator is a  $r_s$ -bank), then  $R_{SB} = 1/p_s$  and the proposed equilibrium does not exist because both  $r_i$ -banks and  $r_s$ -banks would deviate and participate in shadow banking. If those off-equilibrium beliefs are the most “pessimistic” (investors believe the deviator is a  $r_i$ -bank), then  $R_{SB} = 1/p_r$ . In this case the proposed equilibrium with no shadow banking exists as long as  $r_s$ -banks do not have incentives to deviate to shadow banking given those interest rates. This is so as long as

$$\Pi_{SB}\left(r_s \mid R_{SB} = \frac{1}{p_r}\right) = p_s \left[ (1 + \kappa)y_r - \frac{1}{p_r} \right] - \kappa < \Pi_{TB}$$

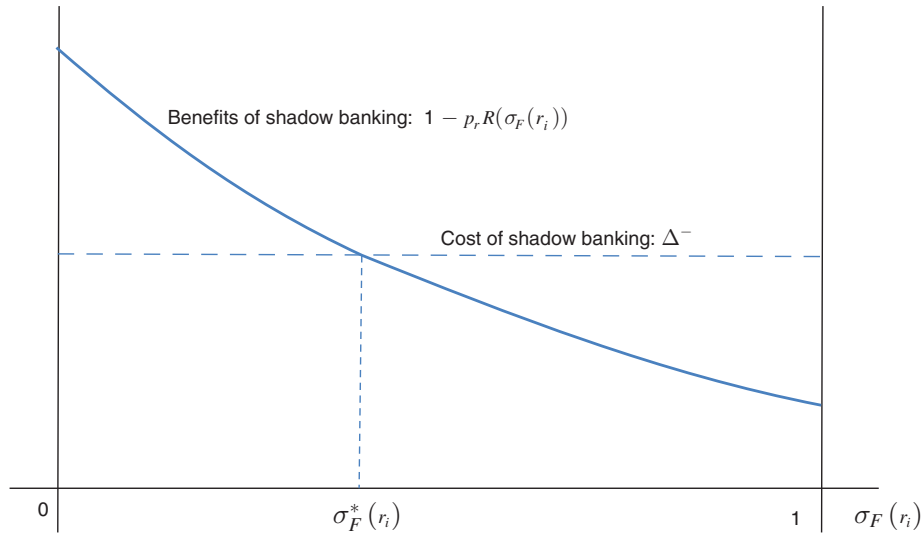
or  $\Delta^+ < \frac{p_s - p_r}{p_r}$ . ■

The equilibrium characterization generates many insights. First, there is no equilibrium in which only banks with access to superior risky assets participate in shadow banking. Because a full separating equilibrium does not exist, the unconstrained first-best allocation cannot be sustained as an equilibrium outcome. If investors believe that only banks with access to superior risky assets participate in shadow banking, they would accept buying securities at a high price, and banks with access to inferior risky assets would be tempted to raise funds in shadow banking too.

The second insight is that an equilibrium with pooling in shadow banking (and then no traditional banking) also does not exist. This equilibrium would only exist if banks do not value the imperfect commitment device provided by regulation (no role for standard regulation), which is ruled out by Assumption 1, point (ii).

The third insight is that an equilibrium with pooling in traditional banking (and then no shadow banking) does not exist if the additional gains from investing in superior risky assets relative to investing in safe assets are high enough and if investors believe that the banks that issue securities are most likely handling superior risky assets. More precisely, the sufficient condition for an equilibrium with shadow banking to be unique requires that the additional gains from investing in the superior risky (this is,  $\Delta^+$ ) are larger than the cost of paying in expectation a higher interest rate, even under the most pessimistic off-equilibrium beliefs (that is,  $1 - p_s \frac{1}{p_r}$ ). Banks that are more tempted to escape regulation are those with access to superior risky assets, and, consequently, an equilibrium without shadow banking is not robust to the Cho and Kreps (1987) criterion.



FIGURE 1. EQUILIBRIUM PARTICIPATION OF  $r_i$ -BANKS IN SHADOW BANKING

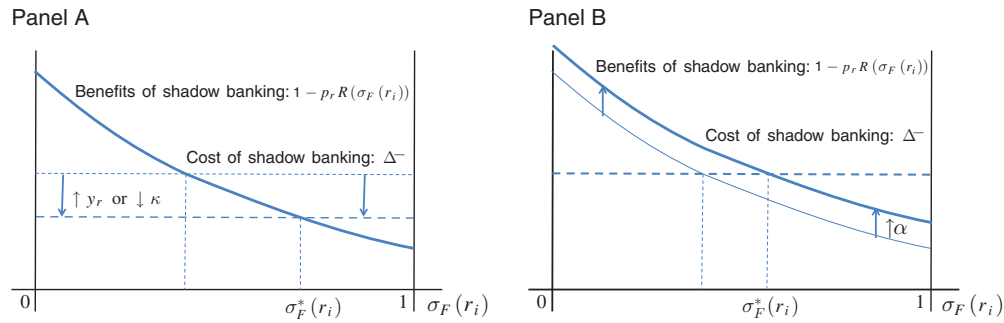
AQ3

Figure I.C depicts how the fraction of banks with access to inferior risky assets that participate in shadow banking is determined in the unique equilibrium. The relative expected gain of participating in shadow banking is that a  $r_i$ -bank pays in expectation less for the loan: instead of paying 1 in expectation when regulated (a rate  $R_{TB}^* = 1/p_s$  with probability  $p_s$ ) it pays  $1/p_r > R_{SB}^* > 1/p_s$  with a lower probability  $p_r$  (then  $p_r R_{SB}^* < 1$ ). These relative gains, depicted by the solid curve in the figure, are decreasing with  $\sigma_F(r_i)$  because  $R_{SB}$  increases with the fraction of  $r_i$ -banks that participate in shadow banking. In equilibrium, these gains have to equalize the relative expected costs of participating in shadow banking—costs that are constant and given by the expected less cash flows from investing in the risky inferior asset instead of being forced to invest in the more efficient safe asset, (this is  $\Delta^-$ ). Note that for  $\sigma_F(r_i) = 0$ , the expected benefits of participating in the shadow banking are always higher than the costs, as indicated in Assumption 1, point (iv).

*Comparative Statics.*—Here I discuss how the participation in shadow banking of banks with access to inferior risky assets is affected by changes in certain parameters of the environment.

First, when banks hold less capital,  $\kappa$ , the relative cost of shadow banking declines (a reduction of  $\Delta^-$ ) because banks have less “skin in the game.” This increases the fraction of banks with access to inferior risky assets that participate in shadow banking, which, in turn, reduces welfare because the equilibrium implements an allocation that is farther from the unconstrained first-best. Second, an increase in  $y_r$ , which is the return of risky assets in the case of success, also reduces the relative cost of shadow banking (a reduction of  $\Delta^-$  too). In equilibrium, this implies a greater participation of banks with access to inferior risky assets in shadow banking. This result is conditional on the increase in  $y_r$  not being large enough to overturn Assumption 1, point ii; the latter would case the regulator to prefer investments in risky assets over investments in safe assets.

AQ4

FIGURE 2. CHANGES OF  $r_i$ -BANKS PARTICIPATION IN SHADOW BANKING

AQ5

The first panel of Figure I.C shows how less  $\kappa$  and more  $y_r$  affects the participation of banks with access to inferior risky assets in shadow banking. These comparative statics are consistent with the large boom in shadow banking that occurred during the decade that preceded the recent 2007–2008 financial crisis; the formed was characterized by a housing bubble (increase in  $y_r$ ) and unprecedented leverage ratios (a decline in  $\kappa$  that increases the leverage ratio captured in the model by  $\frac{1}{1+\kappa}$ ).

A large literature documents how the rise of shadow banking coincided with a period of booming asset prices (particularly residential assets) and was accompanied by very high leverage of financial intermediaries. See, for example, Poznar et al. (2012); Levitin and Wachter (2012); Mian and Sufi (2014); and Jordà, Schularick, and Taylor (2016) for evidence of asset bubbles prior to the recent financial collapse, and see Nuño and Thomas (2017) and Jordà, Schularick, and Taylor (2016) for evidence of bank leverage prior to such collapse. These relations also have been highlighted and explained by other theoretical underpinnings, such as those outlined by Fostel and Geanakoplos (2008), Borio and Zhu (2012), and Adrian and Shin (2014).

The implications of the model also are consistent with the large migration from shadow banking back to traditional banking that was observed after the crisis, when the housing bubble collapsed and the government forced a recapitalization of banks. The model predicts that the growth of shadow banking is driven, first, by a higher participation of  $r_i$ -banks and, second, by a decline in the asset quality at origination. This weakening of banks' asset positions during the period of shadow banking booming has been documented by Acharya et al. (2009), among others.

Finally, an increase in the fraction of banks with access to superior risky assets (an increase in  $\alpha$ ) improves bank composition and investment quality in shadow banking, reducing  $R_{SB}$  and increasing the relative gains of shadow banking. This implies that a compensating effect accompanies the greater participation of  $r_i$ -banks, as depicted in the second panel of Figure I.C.

#### D. Welfare Comparisons

In this environment standard risk-weighted capital requirements improve welfare by providing an imperfect commitment technology. Here I show that allowing shadow banking in the presence of this standard regulation improves welfare even

further, although it does not achieve the unconstrained first-best. I summarize this result, which contrasts with most of the literature and recent regulatory efforts, as follows.

**PROPOSITION 2:** *Preventing shadow banking reduces welfare.*

**PROOF 2:**

Because agents are risk-neutral, total welfare is measured by the sum of banks' profits and investors' endowments. When all banks are forced to raise funds in traditional banking, total welfare is

$$U_{TB} = \Pi_{TB} + (1 + \kappa).$$

Denote by  $f_{SB} = \alpha + (1 - \alpha)\sigma_F^*(r_i)$  the fraction of banks that participate in shadow banking in the unique equilibrium characterized in Proposition 1. Welfare in this case is

$$U_{SB} = f_{SB}[x_s \Pi_{SB}(r_s) + (1 - x_s) \Pi_{SB}(r_i)] + (1 - f_{SB}) \Pi_{TB} + (1 + \kappa).$$

As  $\Pi_{SB}(r_s) > \Pi_{SB}(r_i) = \Pi_{TB}$ , the welfare implemented when shadow banking allowed is strictly larger than the welfare implemented when all banks are forced to raise funds in traditional banking.

More precisely, using  $R_{SB}(\sigma_F^*(r_i))$  in equilibrium, the welfare differential between the equilibrium with shadow banking and the case of only traditional banking is

$$U_{SB} - U_{TB} = \alpha \Delta^+ - (1 - \alpha) \sigma_F^*(r_i) \Delta^-.$$

From Proposition 1, the equilibrium fraction of banks with access to inferior risky assets that participate in shadow banking is

$$(9) \quad \sigma_F^*(r_i) = \frac{\alpha[(p_s - p_r) - p_s \Delta^-]}{(1 - \alpha)p_r \Delta^-}.$$

Then,

$$U_{SB} - U_{TB} = \alpha \left[ \Delta^+ + \frac{p_s}{p_r} \Delta^- - \left( \frac{p_s - p_r}{p_r} \right) \right],$$

and since  $\Delta^+ + \frac{p_s}{p_r} \Delta^- = (1 + \kappa) \left( \frac{p_s - p_r}{p_r} \right) p_s y_s$ ,

$$U_{SB} - U_{TB} = \alpha(1 + \kappa) \left( \frac{p_s - p_r}{p_r} \right) p_s y_s > 0.$$

Shadow banking does not implement, however, the unconstrained first-best because  $\sigma_F^*(r_i) > 0$ . Then,  $U^* - U_{SB} = (1 - \alpha)\sigma_F^*(r_i)\Delta^-$ . Again, replacing with  $\sigma_F^*(r_i)$ ,

$$U^* - U_{SB} = \alpha \left[ \left( \frac{P_s - P_r}{P_r} \right) - \frac{P_s}{P_r} \Delta^- \right] > 0. \blacksquare$$

We can decompose the gains from standard regulation and the additional gains from shadow banking. The welfare differential between the first-best and laissez-faire benchmarks is given by the gap between equations (1) and (2), which is

$$U^* - U_{LF} = (1 - \alpha)\Delta^- > 0.$$

This differential captures the total welfare losses that arise from risk-shifting incentives. Investors know that in laissez-faire, banks always are tempted to invest in risky projects, and thus they charge high rates, which in equilibrium discourages banks from investing in safer, more beneficial alternatives.

We can now compare these losses with those of two alternative scenarios. One is the situation in which a government forces all banks to operate under regulation. This would be the scenario in which the government is successful in discouraging shadow banking activities, which is an explicit goal of the Basel and Dodd-Frank recent regulatory efforts.

In this case, the loss (vis-à-vis the unconstrained first best) is given by

$$U^* - U_{TB} = \alpha\Delta^+ > 0.$$

In other words, strong regulation improves upon laissez-faire, as  $\alpha\Delta^+ < (1 - \alpha)\Delta^-$ , according to Assumption 1, point (ii). Intuitively regulation provides a commitment technology to avoid investments in inferior risky assets, but this commitment is imperfect because it also forces the foregoing of potential investments in superior risky assets. Because the NPV of a safe asset is higher than the average NPV of a risky asset, which the regulator cannot identify as inferior or superior, regulation improves upon laissez-faire, but not enough to implement the first-best.

The second alternative scenario, in which we allow shadow banking to arise in equilibrium and to coexist with traditional banking, is more interesting. Based on the previous two propositions, the loss (again vis-à-vis the unconstrained first-best) is given by

$$U^* - U_{SB} = \sigma_F^*(r_i)(1 - \alpha)\Delta^- > 0.$$

This is naturally smaller than the loss in the case of laissez-faire, given that only a fraction  $\sigma_F^*(r_i)$  of banks that participate in shadow banking end up investing in inferior risky assets. Given that  $\sigma_F^*(r_i)$  is not any number, but an equilibrium object, and referring to equation (9), we have shown in the previous proposition that

TABLE 1—WELFARE AND ALLOCATIONS ACROSS FOUR SCENARIOS

Welfare	First-best $U^* >$	SB and TB $U_{SB} >$	Only TB $U_{TB} >$	Laissez-faire $U_{LF}$
Investments				
$r_s$	$\alpha$	$\alpha$		$\alpha$
$s$	$1 - \alpha$	$(1 - \alpha)(1 - \sigma_F^*(r_i))$	1	
$r_i$		$(1 - \alpha)\sigma_F^*(r_i)$		$1 - \alpha$

$(1 - \alpha)\sigma_F^*(r_i)\Delta^- < \alpha\Delta^+$ . This implies that allowing for shadow banking complements standard regulation and improves welfare further.

Table 1 schematically summarizes these four scenarios, which are ordered by welfare in descending order: unconstrained first-best, the coexistence of traditional and shadow banking, only traditional banking, and laissez-faire. We also show schematically the different allocations (in terms of investments in safe assets, superior risky assets, and inferior risky assets) that induce the resulting welfare ordering.

This comparison across scenarios is critical in light of recent large efforts to eliminate shadow banking completely from operating in financial markets. Capital requirements provide a better outside option to banks than no regulation at all. Then the banks that are more likely to escape regulation are indeed those that have better investment opportunities. Given that operating under the oversight of regulators is a choice, this asymmetric movement away from regulation can only be beneficial. In other words, allowing for shadow banking is not the same as saying that the system would function better without standard regulation. The latter would be a case of laissez-faire, which is the worse possible scenario in this setting. Both regulation and the alternative of optimally escaping from such regulation are important elements in the improvement of welfare.

## II. Optimal Regulation

The previous analysis shows that just imposing restrictions on banks' investments (consistent with the way regulation operates in practice) has the advantage of improving allocations relative to an equilibrium without regulation. This result is relatively trivial as I have endowed the government with a monitoring technology that investors do not have. This assumption is consistent with the usual rationalization of regulation—that is, with the premise that governments can more credibly force banks to disclose information and then impose restrictions on the basis of that information.

Less trivially I have shown that shadow banking complements traditional banking and standard regulations to further improve welfare, which is in stark contrast to strong new regulatory proposals intended to asphyxiate shadow banking. Although shadow banking arises as a market reaction to avoid excessive regulations, it is used mostly by banks with access to superior investment possibilities. This increase in investment efficiency, however, comes at the cost of increasing risks by attracting



banks with inferior investment opportunities too. This “contamination” in the pool of banks participating in shadow banking activities is what prevents shadow banking from implementing the unconstrained first best. More technically, a full separating equilibrium cannot be sustained as an equilibrium outcome.

Can the government use its superior technology more effectively to achieve an allocation closer to the unconstrained first best? Can the government use banks’ incentives to escape regulation in its favor and thus create a sustainable and more efficient shadow banking? I show that the government can indeed implement the first-best allocation with a direct revelation mechanism in which banks choose whether to be regulated or not. The government restricts the investment of those banks that choose to be supervised and subsidize their activity by imposing a tax on banks that choose to be not regulated.

Then, from a practical point of view, this result shows that welfare can be maximized not by imposing stricter capital requirements on all banks (which would reduce welfare), but by imposing taxation on institutions that would rather not being subject to regulation and subsidizing those that agree to do so. First, I show that such a mechanism does exist, and, second, I discuss its budget-balanced implementation through taxes and subsidies.

**PROPOSITION 3:** *There is a direct revelation mechanism that implements the unconstrained first-best allocation.*

**PROOF 3:**

A direct revelation mechanism consists, first, of banks that report their risky assets’ quality,  $\hat{r} \in \{\hat{r}_s, \hat{r}_i\}$ , and, second, of the principal that chooses the probability of investing in the risky asset,  $q(\hat{r}) \in [0, 1]$ , and the transfers to investors upon success,  $T(\hat{r}) \geq 0$ , both conditional on the report. Notice that I have already imposed limited-liability constraints such that transfers in the case of failure are zero.

Truth-telling constraints for  $r_s$ -banks are

$$(10) \quad q(\hat{r}_s)p_s[(1 + \kappa)y_r - T(\hat{r}_s)] + (1 - q(\hat{r}_s))p_s[(1 + \kappa)y_s - T(\hat{r}_s)] \\ \geq q(\hat{r}_i)p_s[(1 + \kappa)y_r - T(\hat{r}_i)] + (1 - q(\hat{r}_i))p_s[(1 + \kappa)y_s - T(\hat{r}_i)],$$

and for  $r_i$ -banks,

$$(11) \quad q(\hat{r}_s)p_r[(1 + \kappa)y_r - T(\hat{r}_s)] + (1 - q(\hat{r}_s))p_s[(1 + \kappa)y_s - T(\hat{r}_s)] \\ \leq q(\hat{r}_i)p_r[(1 + \kappa)y_r - T(\hat{r}_i)] + (1 - q(\hat{r}_i))p_s[(1 + \kappa)y_s - T(\hat{r}_i)].$$

The ex ante participation constraint of investors is

$$(12) \quad \alpha p_s T(\hat{r}_s) + (1 - \alpha)(q(\hat{r}_i)p_r + (1 - q(\hat{r}_i))p_s)T(\hat{r}_i) \geq 1.$$

Imposing the first-best allocation (this is  $q(\hat{r}_s) = 1$  and  $q(\hat{r}_i) = 0$ ) from equations (10) and (11), transfers are constrained by

$$(1 + \kappa)\left(y_r - \frac{p_s}{p_r}y_s\right) + \frac{p_s}{p_r}T(\hat{r}_i) \leq T(\hat{r}_s) \leq (1 + \kappa)(y_r - y_s) + T(\hat{r}_i).$$

This equation immediately implies that  $T(\hat{r}_s) > T(\hat{r}_i)$  (as  $T(\hat{r}_s) = T(\hat{r}_i)$ , which violates the first inequality according to Assumption 1, point (iv)). Equalizing the first binding inequality and replacing  $T(\hat{r}_s)$  in the participation constraint with investors who break even, we obtain

$$T(\hat{r}_i) = \frac{1}{p_s} - t(\hat{r}_i)$$

where

$$t(\hat{r}_i) = \frac{\alpha}{\alpha p_s + (1 - \alpha)p_r}D$$

and

$$D \equiv \left[ p_r \left( (1 + \kappa)y_r - \frac{1}{p_s} \right) - p_s \left( (1 + \kappa)y_s - \frac{1}{p_s} \right) \right] > 0,$$

positive by Assumption 1, point (iv). Then,

$$T(\hat{r}_s) = \frac{1}{p_s} + t(\hat{r}_s)$$

where

$$t(\hat{r}_s) = \frac{(1 - \alpha)}{\alpha p_s + (1 - \alpha)p_r}D.$$

The unconstrained first best is always implementable (this is  $T(\hat{r}_s) \leq (1 + \kappa)y_r$ ) as all projects are efficient. ■

This direct revelation mechanism implements the first-best allocation because it requires investors to break even ex ante. This would be sustained in equilibrium if investors could commit funds to finance assets before knowing whether they will finance an asset through traditional or shadow banking. This is an important constraint for equilibrium implementation. The mechanism specifies that banks with access to inferior risky assets pay in expectation less than the fair price of the loan (this is less than  $1/p_s$ ). Consequently they are indeed willing to be forced to invest in safe assets, or in terms of regulation, they are willing to operate in traditional banking. Investors, however, are not willing to lend funds to regulated banks if they know in expectation that those banks will pay in expectation less than the loan.

If the government has taxation power, however, it can subsidize regulated banks and then satisfy the ex post participation constraints of investors. In other words, the

government can subsidize regulated banks such that they pay enough to investors to fund their activities but effectively face lower rates that do not induce them to take excessive risks. Next I describe a self-financed cross-subsidization that implements the first-best allocation.

**PROPOSITION 4:** *To implement the first-best allocation the government should offer to regulate all banks that request it, thus forcing them to invest in safe assets. The government also should impose taxes  $t(\hat{r}_s)$  on banks that choose not to be regulated and subsidize by  $t(\hat{r}_i)$  those that do. Banks both in traditional and shadow banking pay the same rate  $1/p_s$  for the loan, and so investors are ex post indifferent between lending to traditional or to shadow banks.*

**PROOF 4:**

The first-best allocation implies that the probability of repayment is always  $p_s$  because banks with access to superior risky assets invest in those assets and banks with access to inferior risky assets invest in safe assets; both have a probability of success  $p_s$ . This implies that ex post investors break even in each case if  $R = 1/p_s$ . We have shown that if those banks that have superior and inferior risky assets pay for funds  $T(\hat{r}_s)$  and  $T(\hat{r}_i)$  respectively, then they will self-select into traditional and shadow banking (and invest) efficiently.

Charging  $t(\hat{r}_s)$  to the mass  $\alpha$  of shadow banks (such that their effective cost of funding is  $T(\hat{r}_s) = 1/p_s + t(\hat{r}_s)$ ) to subsidize  $t(\hat{r}_i)$  to the mass  $(1 - \alpha)$  of traditional banks (such that their effective cost of funding is  $T(\hat{r}_i) = 1/p_s + t(\hat{r}_i)$ ) is feasible because

$$\alpha t(\hat{r}_s) = (1 - \alpha)t(\hat{r}_i). \blacksquare$$

In summary, competition among investors is a critical force behind the inefficiency in our setting. In spite of asymmetric information and the banks' unwillingness to use their skills on the behalf of debtholders, what prevents banks from investing efficiently without resorting to excessive risk-taking is that investors do not break even ex post when they finance assets in traditional banking. If investors were able to set up an institution that collects funds and then implements a direct revelation mechanism like the one described above, then there would not be any need for standard regulation or cross subsidization. This result is consistent with the findings of Prescott and Townsend (1984); Arnott, Greenwald, and Stiglitz (1993); and, more recently, Atkeson, Hellwig, and Ordoñez (2015), who examine the scope of Pareto improving interventions when information imperfections cannot directly be overcome.

### III. Conclusions

This paper provides a new, more positive view of shadow banking, not as an inherently dangerous system without regulatory firewalls but as a means by which banks bypass inefficient government restrictions when they can self-regulate. Because self-regulation is provided by access to superior investment opportunities,

which entail low risk and high returns, it attracts the participation of other banks that have inferior risky projects, which are characterized by high risk and high returns; the latter try to escape regulation to invest at the expense of debtholders, thus “contaminating” the pool of banks participating in shadow banking activities. I show that, in equilibrium, the gains of shadow banking in terms of efficiency overcome its costs in terms of higher risks.

In addition to showing that shadow banking improves welfare and does not simply introduce more risk in the economy, I discuss a novel regulatory tool that combines traditional capital requirements with cross-subsidizations to further enhance the benefits of shadow banking. With this novel regulation, banks with access to superior assets are willing to pay to escape regulations, and those payments can be channeled to banks without access to superior assets to self-select into being regulated and forgo risk-shifting incentives. This cross-subsidization, implementable with taxes and subsidies, would sustain a shadow banking sector that invests efficiently without succumbing to the temptation of excessive risk taking.

Although for expositional reasons I have focused attention on asset backed commercial paper (ABCP), the insights of the paper also apply to all other forms of securitization and investment vehicles used to remove assets from financial intermediaries’ balance sheets (including but not limited to collateralized debt obligations, mortgage securities, credit default swaps, and repurchase agreements). The results also apply to the operation of unregulated financial intermediaries that get involved in activities that usually are performed by institutions overseen by regulators, such as money market funds, investment banks and mortgage companies.

Given the goal of exploring how different asymmetries across financial agents interact to determine allocations, I have left aside other interesting aspects of financial crises that would complicate the exposition of the main mechanism. In the paper, for example, the participation of banks in traditional and shadow banking happens in a relatively orderly way and does not capture the nuances of crises that are driven by bubbles or runs. Similarly, the paper models not securitization and its details but the use of securitization for regulation arbitrage and its effects. Combining these elements into a single setting would be a promising endeavor for future research.

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**PLEASE ANSWER ALL AUTHOR QUERIES (numbered with “AQ” in the margin of the page). Please disregard all Editor Queries (numbered with “EQ” in the margins). They are reminders for the editorial staff.**

AQ#	Question	Response
1.	I changed this to point iv to reference iv under Assumption 1. Is this ok?	Yes, Thanks!
2.	Should this be ‘on an off-balance sheet’?	See response below
3.	Where is Figure I.C? Check throughout.	In page 14 it should say Figure 1 and in page 15 it should say Figure 2 (in two lines, first and last)
4.	‘...the latter would case?’	See response below
5.	The formed what? Something appears to be missing.	See response below

## RESPONSE FOR AQ2

## PLEASE REPLACE

“by selling part of the asset and placing it off-balance sheet, banks can avoid investment restrictions if capital requirements do not bind when investing in risky assets. This is, banks avoid regulations as long as”

## WITH

“by selling part of the asset and recording it as an off-balance sheet asset, banks can avoid investment restrictions as long as”

## RESPONSE FOR AQ4

## PLEASE REPLACE

“the latter would case the regulator to prefer investments in risky assets over investments in safe assets.”

## WITH

“otherwise the regulator would also prefer investments in risky assets.”

## RESPONSE FOR AQ5

## PLEASE REPLACE

“...the recent 2007–2008 financial crisis; the formed was characterized....”

## WITH

“...the recent 2007–2008 financial crisis; a decade characterized...”